

## 5 Harlan County Lake

### 5.1 General Background

Harlan County Lake was impounded on 14 November 1952 and reached full pool on 14 June 1957. The primary water quality threats to Harlan County Lake are nutrients, sediment and toxic cyanobacteria blooms. A drought continues to seriously impact the lake such that it currently contains one-half the surface acreage. Sample site 5 replaced site 7 during 2003 because site 7 was no longer accessible due to the drought. During normal water level years, the lake experiences a 4 – 6 ft drawdown related to irrigation releases (June – August). Dredging has occurred to maintain boat access to both the Patterson Harbor marina and the Gremlin Cove marina. Bluegreen algae blooms have occurred at the lake in the recent past.

#### 5.1.1 Location

The Harlan County Lake is located 12.8 km (8 miles) east of Alma, Nebraska. The dam, located on the Republican River, is located 371.7 km (232.3 miles) upstream of the confluence with the Kansas River. Historic water quality sample sites include 3 lake, 1 outflow, and 1 inflow sites (Figure 5.1).

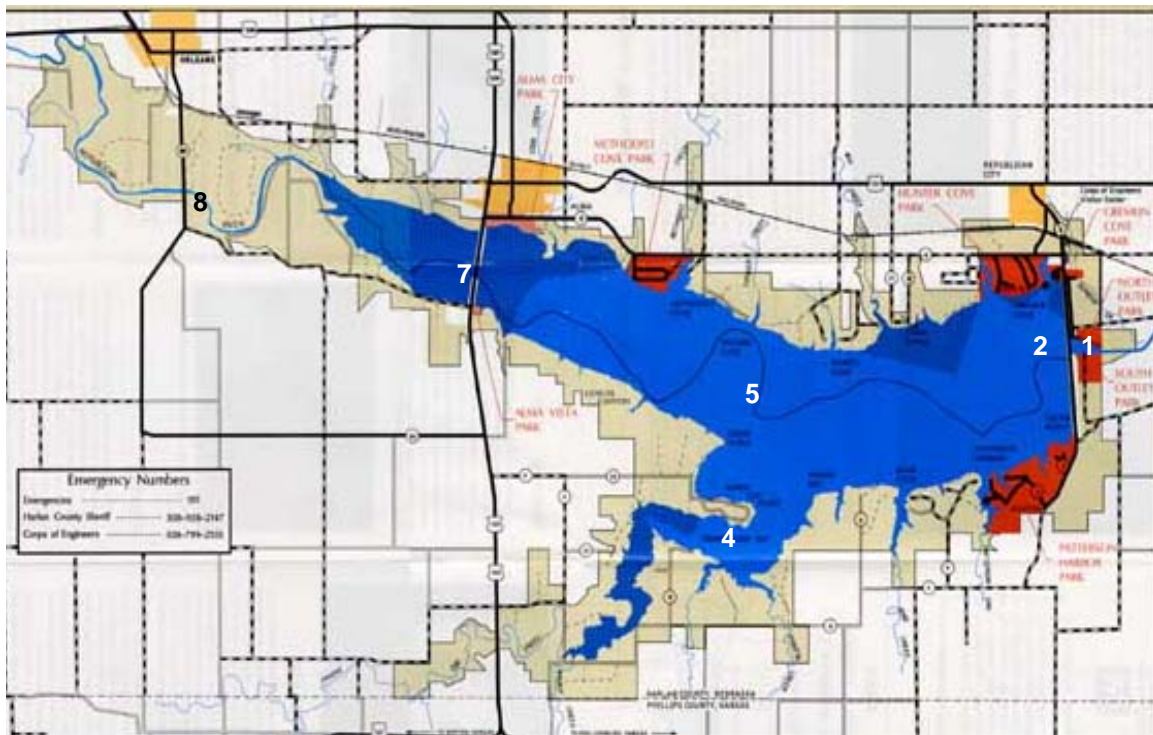


Figure 5.1. Harlan County Lake area map with sample site locations and site numbers.

**5.1.2 Authorized Purposes:** flood control, irrigation, recreation, and fish and wildlife.

**5.1.3 Lake and Watershed Data**

Pools	Surface Elevation (ft. above m.s.l.)	Current Capacity (1000 AF)	Surface Area (A)	Shoreline (miles)
Flood Control	1,973.5	500.0	23,431	54
Multipurpose	1,946.0	314.1	13,305	
Total		814.1		

Total watershed area: 13,536 sq miles (total upstream area)  
7,169 sq miles (total local drainage below upstream dams;  
4,588,160 A)

Watershed ratio: 195.82 FC / 344.84 MP

Average Annual Inflow: 258,658 acre-feet

Average Annual outflow: 000 acre-feet

Sediment inflow (measured): 38,548 acre-feet (1952 – 2000)

## 5.2 2005 Activities

Harlan County Lake was categorized as an ‘intensive’ lake during 2005, with sample collection occurring from May through September. Surface samples were to be collected from inflow and outflow sites, while surface and bottom samples were collected at the three lake sites. Vertical profiles (temperature, DO, pH, conductivity, and turbidity) were recorded at the three lake sites during each sampling trip. However, because of the drought, no inflow or outflow samples were collected during the year. Harlan County Lake staff (OF-HC) providing field sampling assistance during 2005 included Larry Janicek and Jim Brown. Jim Bowen, OF-HC Operations Manager, provided insight and background information regarding Harlan County Lake.

## 5.3 2005 Data

### 5.3.1 Inflow

No inflow samples were collected due to the prolonged drought impacts. No visible water was present at site 8 throughout the study period. No samples have been collected at site 8 since July 2003 because of dry conditions.

### 5.3.2 Lake

Based on TN, TP and chlorophyll a concentrations, Harlan County Lake is classified very eutrophic. Total nitrogen concentrations from surface samples are relatively consistent between lake sites, ranging from 1.04 – 1.39 mg/L (Figure 5.2). These concentrations are significantly greater than EPA’s proposed ecoregional nutrient criteria target of 0.56 mg/L, and are among the highest median TN concentrations within our district.

Some of the highest median concentrations of total phosphorus within the district were recorded at Harlan County Lake (Figure 5.3). The median values range from 0.23 – 0.44 mg/L, which is significantly greater than the proposed EPA ecoregional nutrient criteria of 0.033 mg/L. The high sediment inflows and resuspension of materials

potentially increases the bioavailability of this nutrient, which is essential for algal blooms.

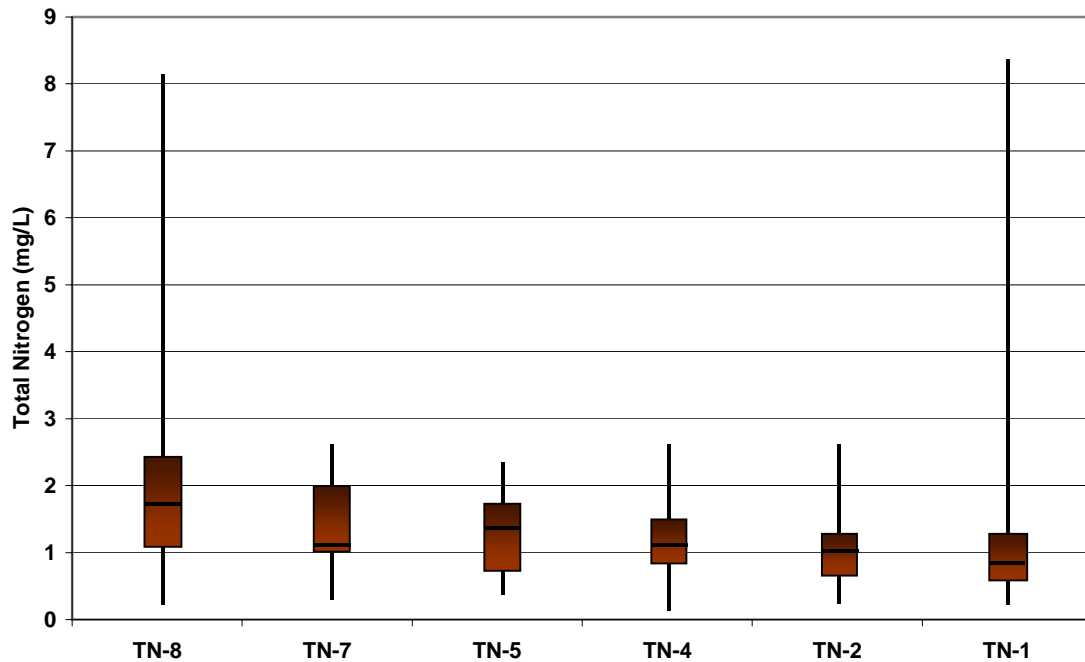


Figure 5.2. Box plots of surface water sample total nitrogen concentrations measured by site from 1996 through 2005 at Harlan County Lake.

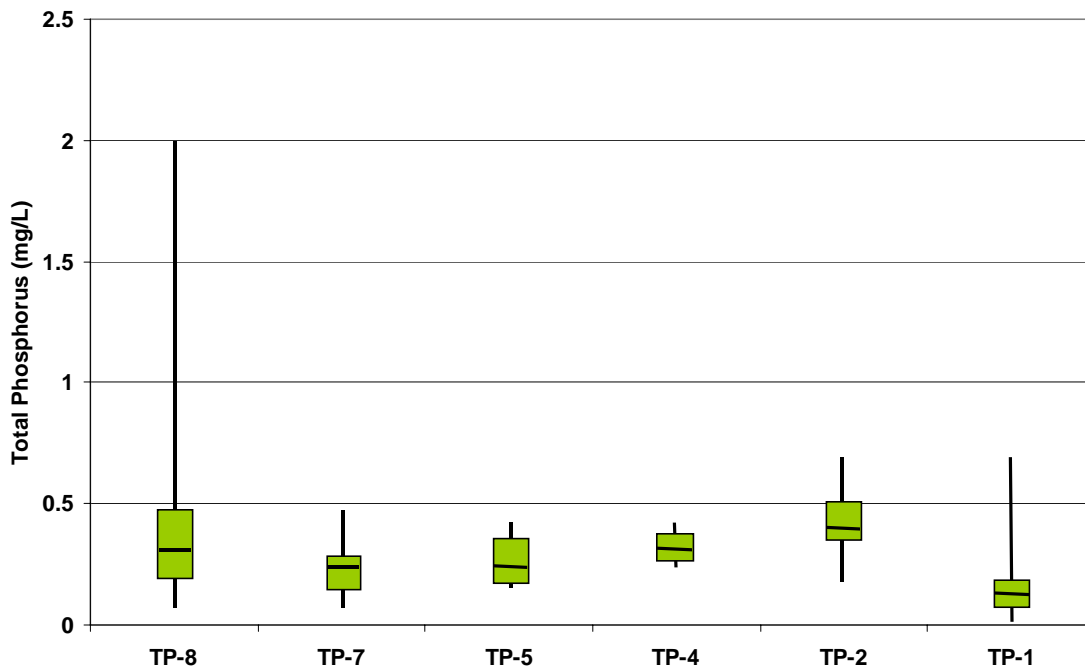


Figure 5.3. Box plots of surface water sample total phosphorus concentrations measured by site from 1996 through 2005 at Harlan Count Lake.

As a result of the elevated TP concentrations, Harlan County experiences some of the lowest median TN : TP ratio values within the district. There is high monthly and annual variability in TN : TP ratios at all sites, with lowest ratios typically present during late summer and fall months. Figure 5.4 is an example of such variability as measured at Site 2. Median values range from 5.5 – 7.2 (Figure 5.5), which is strongly indicative for the presence of bloom-forming cyanobacteria (blue-green algae). Thus, this lake is at risk for future cyanobacteria blooms, which pose a serious threat to animals and humans. Recently, lakes in Nebraska have experienced outbreaks of toxic cyanobacteria blooms.

Chlorophyll a concentrations ranged from 12.15 – 40.08 ug/L from samples collected during 2005. These values are indicative of a highly eutrophic environment, and were expected based on historic nitrogen and phosphorus concentrations.

Atrazine samples were collected from surface samples at all three lake sites during 2005. As one would expect with a seasonally applied herbicide, monthly and seasonal variability in concentrations is experienced at all sites. Median atrazine concentrations (0.95 – 1.1 ug/L; Figure 5.6) from samples collected between 1996 and 2005 are less than the EPA drinking water MCL of 3 ug/L. However, spikes measured during spring samples have exceeded the MCL. Highest concentrations historically have been measured at Site 8 (Republican River inflow), with values ranging from 0.08 – 12 ug/L.

Secchi depths at Site 2 ranged from 0.18 – 0.69 m, which is significantly less than EPA's ecoregional target of 1.3 m. Historically high sediment inflows have impacted water clarity. Resuspension of sediment related to prevailing winds and shallow depth (drought) most likely influence current water clarity. Total suspended solids (TSS) samples corroborate the reduced water clarity, as TSS concentrations from surface samples ranged from 5 – 51 mg/L and near-bottom samples ranged from 21 – 210 mg/L.

Total organic carbon (TOC) concentrations from surface and near-bottom water samples ranged from 7 – 10 mg/L., with most variability and elevated measurements associated with surface samples. Elevated TOC concentrations are associated with oxygen reductions.

Total iron exceeded EPA's Drinking Water Standard of Secondary Maximum Contaminant Levels (SMCL) of 300 ug/L from surface samples collected during August at all three lake sites. Concentrations ranged from 448 – 894 ug/L, with the highest concentration recorded at Site 4 (Prairie Dog Bay). Implications are directed at drinking water facilities related to taste and staining issues. In addition, all surface samples collected during August exceeded EPA's SMCL for manganese (50 ug/L). Sample concentrations ranged from 53 – 91 ug/L, with lowest concentrations measured at Site 5 (midlake). Implications are directed at drinking water facilities due to taste and stain issues.

Arsenic samples exceeded the EPA Drinking Water Standard (10 ug/L) from surface samples collected during August at all three lake sites. The concentrations ranged from 15 – 20 ug/L. Implications are related to drinking water utilities, which must reduce the elevated concentrations for health reasons.

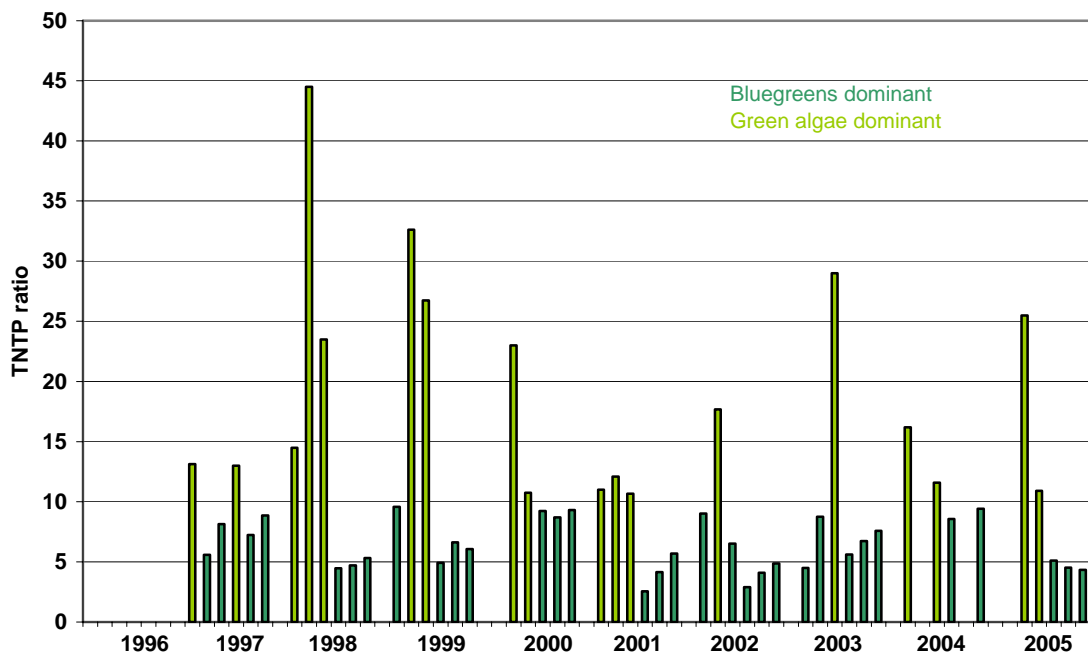


Figure 5.4. Graph of total nitrogen : total phosphorus ratio (TN:TP) by sample at Site 2 of Harlan County Lake from 1996 through 2005.

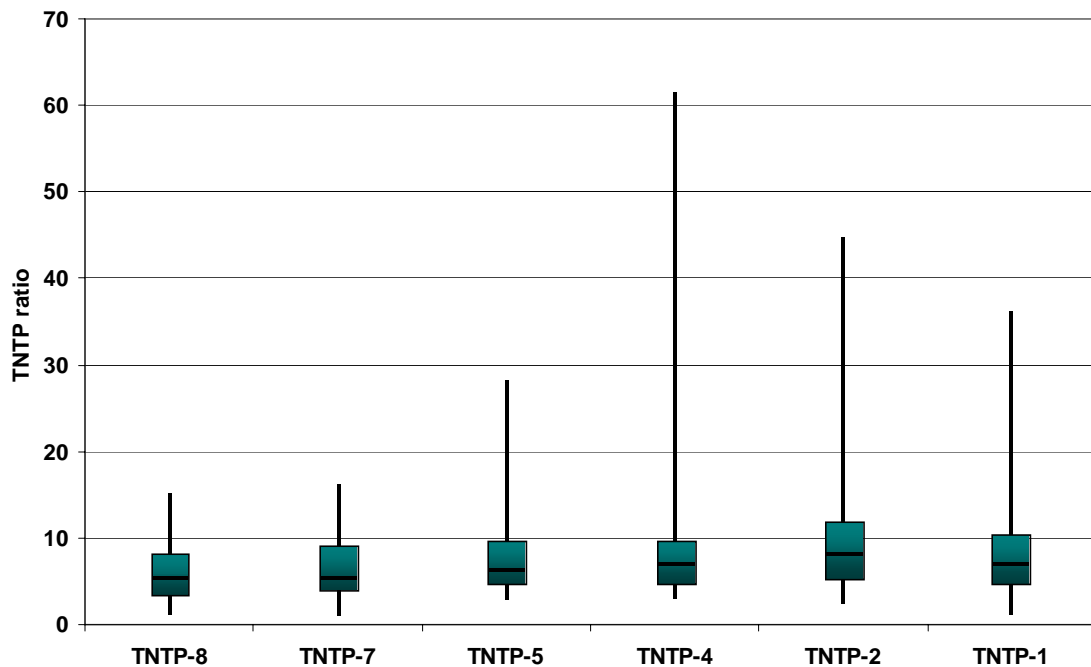


Figure 5.5. Box plots of total nitrogen : total phosphorus ratio from surface water samples by site from 1996 through 2005 at Harlan County Lake.

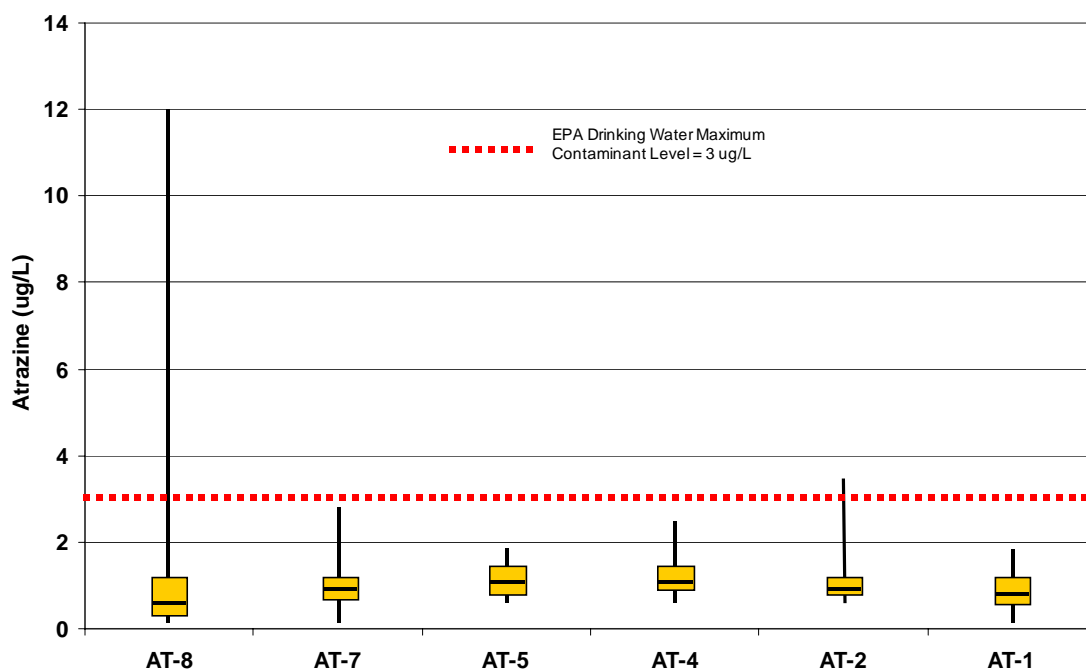


Figure 5.6. Atrazine concentrations by sample site at Harlan County Lake from 1996 through 2005.

Vertical profiles were recorded during June, July and September sampling trips. Parameters included temperature, dissolved oxygen, pH, conductivity, and turbidity. Based on these profiles, the lake stratified both thermally and chemically between a depth of 3 – 4 m during June and a depth of 6-7 m during July (Figure 5.7). Stratification is typical of eutrophic lakes, and weak stratification is expected in south-central Nebraska lakes due to strong prevailing winds. These winds keep the lake mixed both thermally and chemically. The lake had ‘turned over’, or destratified, by the mid-September sample trip.

Fecal coliform (*E coli*) bacteria were monitored by lake personnel prior to three major holidays (i.e., Memorial Day, 4<sup>th</sup> of July, Labor Day) during the 2005 recreational season. None of the median values exceeded NDEQ’s single sample maximum (235 colonies / 100 ml) during 2005 (Figure 5.8). In addition, *E coli* samples were last collected by NDEQ at the north swimming beach during 2002. The results were highly variable during the recreational season (Figure 5.9). Two samples exceeded the single sample maximum, while another two samples exceeded the single sample maximum but failed their internal QAQC protocol.

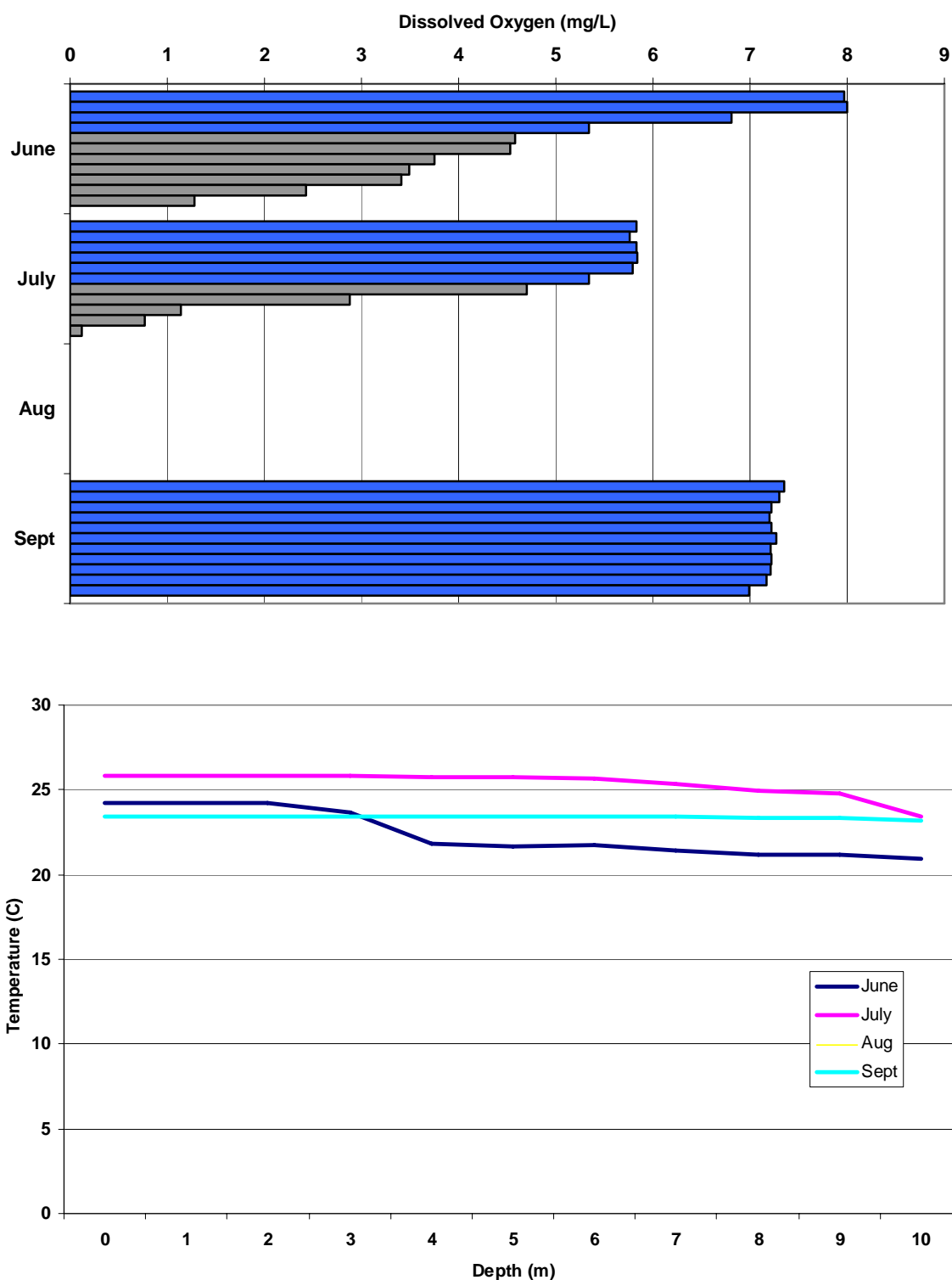


Figure 5.7. Dissolved oxygen concentration (mg/L) histogram and temperature (C) plots by sample dates from vertical profiles recorded at Site 2 during 2005 at Harlan County Lake.

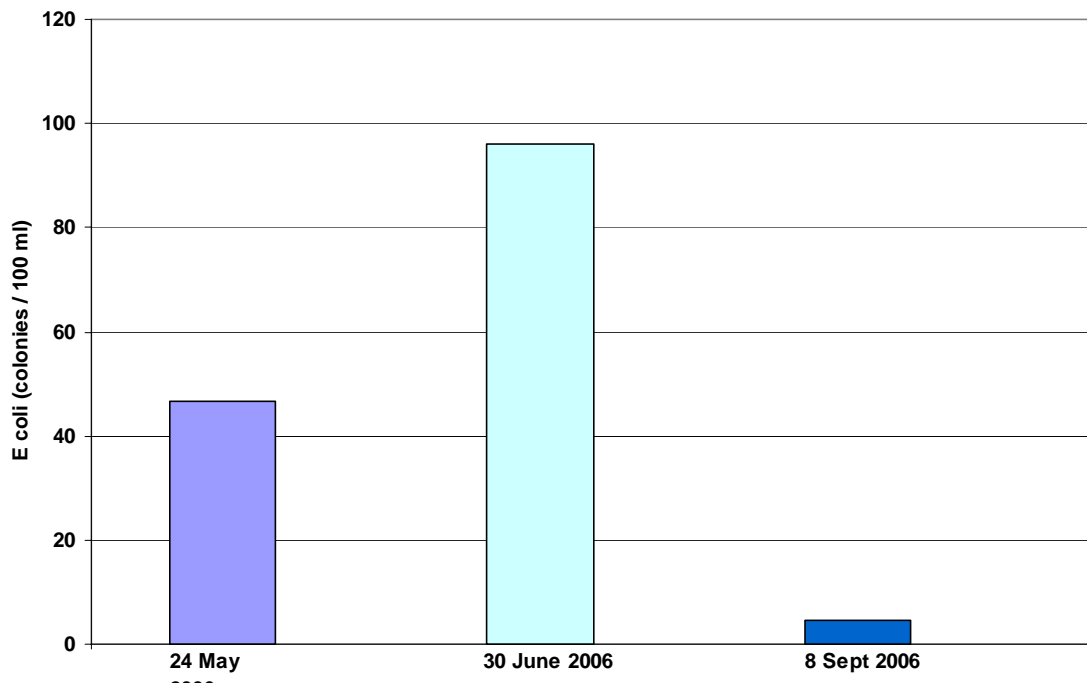


Figure 5.8. Fecal bacteria (E coli) monitoring results from USACE pre-holiday monitoring at Harlan County Lake's north beach during 2005.

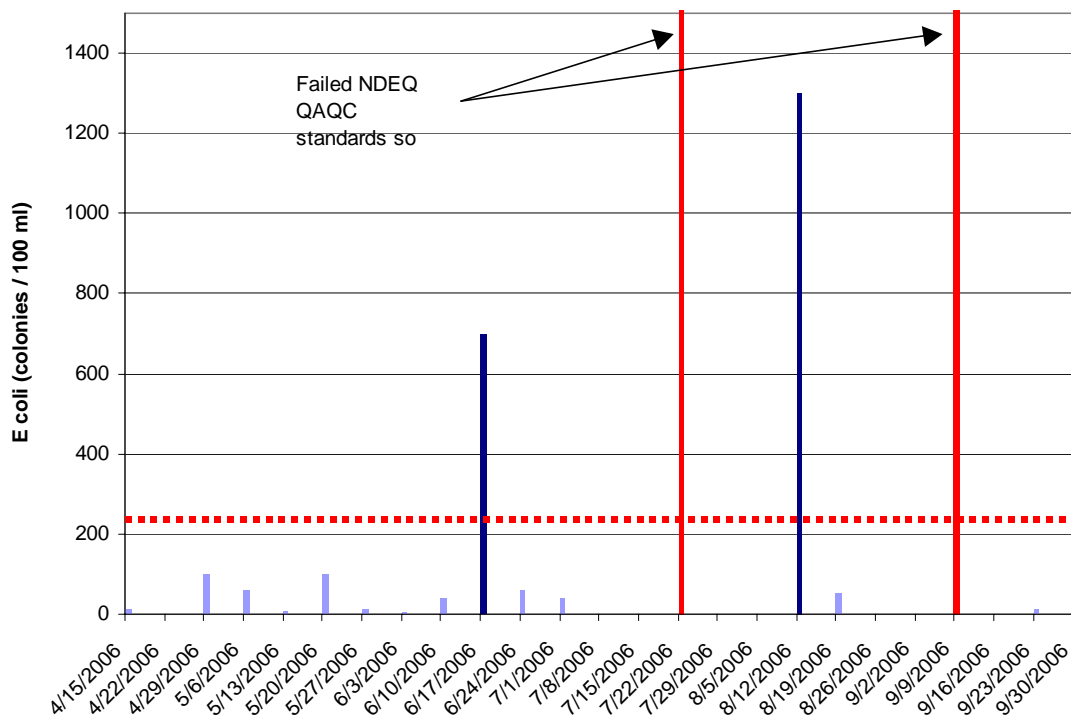


Figure 5.9. Fecal bacteria (E coli) monitoring results from NDEQ 2002 weekly testing at Harlan County Lake's north beach.



### **5.3.3 Outflow**

Because no water has been released from the lake the past two years, no outflow samples (site 1) have been collected since 2003.

### **5.4 Future Activities and Recommendations**

Sampling activities for 2006 will include transition to monthly 'ambient' monitoring from May through September, as well as conducting at least one summer vertical profile at each of the three lake sites. Due to elevated TP concentrations and low TN : TP ratios, this lake should be monitored for microcystin and other toxins associated with cyanobacteria. No watershed group exists currently at Harlan County Lake, and this may be difficult to generate interest due to extended drought conditions. The Nebraska Game and Parks Department (NEGP), Nebraska Department of Environmental Quality, NRCS, and local municipalities should be contacted in hopes of developing such a group. The NEGP will implement an aquatic habitat project in Harlan County Lake in the future. The project will include installation of a large jetty designed to protect a boatramp at Cedar Point, as well as stabilize eroding shorelines around the lake.

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